LIBRARY COPY
JUN 21 1965
ONTARIO WATER
RESOURCES COMMISSION

ANNUAL REPORT

1962

CITY OF WATERLOO

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

WATERLOO WATER POLLUTION CONTROL PLANT

PROJECT NO. 58-S-22

OPERATED FOR

THE CITY OF WATERLOO

BY

THE ONTARIO WATER RESOURCES COMMISSION

Mr. A. M. Snider	Chairman
Dr. A. E. Berry	General Manager
Mr. D. S. Caverly	Asst. General Manager and Director of Plant Operations
Mr. B. C. Palmer	Asst. Director and Supervisor of Sewage Projects
Mr. D. A. McTavish	Project Engineer, Division of Plant Operations

WATERLOO WATER POLLUTION CONTROL PLANT

GENERAL

In May of 1956 the Consulting Engineers, Proctor & Redfern submitted a report recommending an extension to the primary sewage treatment plant in Waterloo. They proposed that the plant be extended to a four million gallons per day activated sludge plant and that as much use as possible be made of the old plant equipment.

Ontario Municipal Board approval was obtained in 1958 and construction was completed by early 1960. The Plant Operations Division assumed responsibility for the operation of the plant on April 1st, 1960.

A great deal of difficulty was experienced in the operation of this plant during the remainder of 1960. Shock loads and sewages with pH's varying from 3.5 to 11.5 within an hour, were experienced. Bulking sludge, septic conditions and poor effluents resulted from the extreme conditions indicated above. The 1960 Annual Report indicated that the average sewage strength was from 3 to 4 times that experienced at other plants. Operation was further complicated by equipment problems and the lack of dual units which would have provided some flexibility. Some of the more extreme equipment problems were those associated with the skip hoist, flow-meter, air compressors and chemical pumps.

During 1961, some of the equipment problems that plagued the plant in 1960 were resolved. Changes were made to the skip hoist and its operation since then has been more satisfactory. The loading on the plant increased during 1961 as compared with 1960 and the problem of varying pH persisted during the year.

DESIGN DATA

The 4.0 million gallons per day Waterloo Water Pollution Control Plant was designed by Proctor & Redfern and constructed by Ball Brothers Limited. The plant is designed to handle flow rates of 4.0 MGD for 12 hour periods with peaks of 5.6 MGD.

(1) Inlet Works

Flow enters the plant via two trunk sewers. The sewage first passes through a mechanically cleaned bar screen and then is measured as it flows through an 18 inch Parshall flume. Grit is then removed by a 12 foot square detritor which is one foot seven inches in depth and affords 30 seconds retention at design flow.

(2) Primary Clarifier

A 75 foot diameter clarifier receives sewage from the grit removal unit. The clarifier has a 9 foot side wall depth with a 12 foot depth at the centre. The volume of the tank is 276,000 Imperial gallons which affords a 1.66 hour detention at design flows. The clarifier has a weir loading of 17,000 gallons per foot per day and a surface loading of 906 gallons per square foot per day.

(3) Aeration Section

Settled sewage from the primary clarifier flows by gravity to four single pass aeration tanks. Each tank is 136 feet long, 30 feet wide and 15 feet in depth giving a total volume of 1.5 million gallons for all four tanks. Air is supplied by two air compressors each rated at 3,750 cubic feet of air per minute.

(4) Secondary Clarifiers

Two 65 foot diameter clarifiers with a 10 foot side wall depth and a 12.5 foot centre depth receive the mixed liquor from the aeration section. Each tank has a volume of 230,000 Imperial gallons and these clarifiers give 2.75 hours detention at design flow.

(5) Vacuum Filtration

Activated and raw primary sludge is stored in the primary clarifier and pumped to the vacuum filtering unit. This unit is a 300 square foot Komline-Sanderson stainless steel coil spring vacuum filter. After filtration the vacuumed sludge is lifted by a skip hoist to an elevated storage bin. The sludge is then dumped into trucks and disposed of on farm lands by a sludge haulage contractor.

OPERATING RESULTS

(1) Plant Loadings

The suspended solids and BOD loads continued to increase during 1962. These increases over the 1961 loadings are shown on Graph # 1 and Graph # 2. The tons of BOD and suspended solids in the raw sewage increased by 50 percent and 83 percent respectively. This large increase was quite unexpected.

The BOD and SS loadings are shown month by month on the bar graphs (Graph # 3 and Graph # 4). The monthly loadings were much higher during 1962 with the heaviest loadings occurring during the latter part of the year. With the exception of July of 1961, the BOD and SS loadings reached their peaks during the latter portion of each year. The tons of material shown for December of 1962 were based on only one eight hour composite sample. The laboratory reports for the remaining samples were not available at the time of preparation of this report.

Graph # 5 indicates the accumulated flows during 1961 and 1962 with an overall increase of 13 percent. The flow therefore increased but this increase was small compared with those experienced in the BOD and SS loadings. The increased plant loadings, then, resulted from higher concentrations of BOD and SS in the incoming raw sewage. These concentrations are shown on Table 2 and in Graph # 6 and Graph # 7. The average concentration of BOD and SS during the year was 766 ppm and 539 ppm as compared with 585 ppm and 423 ppm during 1961.

The lines on Graph # 6 and Graph # 7 have been made up from approximately 100 composite samples. The results have been expressed as percent of samples equal to or greater than various concentrations of BOD and suspended solids. These graphs indicate the unusually high strengths of sewage which must be dealt with by the plant. For example, the strength of BOD in the raw sewage was greater than 700 ppm 40 percent of the time. Normal domestic sewage is considered to have a BOD of from 200 to 300 ppm but, as seen from the graph, only 5% of the samples had a concentration less than 300 ppm.

It is also evident from the graphs that the primary effluent had a higher concentration of BOD than did the raw sewage. This resulted from the return of large amounts of waste activated sludge which grew as a result of the strong sewage. The waste activated sludge had a poor settling characteristic, due to the overloaded aeration tank conditions, and as a result, could not be removed from the system and recycled through the process. During July, a modification was made to the conventional process and a process similar to contact stabilization was established.

This process has enabled the plant to handle an even stronger sewage (average of 900 ppm BOD) since August. The primary effluent since August has been of better quality than the raw sewage but still shows the effect of an overloaded system.

The bottom line on each graph depicts the final effluent and in both incidents 98% of the samples had concentrations of BOD and SS exceeding 30 ppm. The objectives of the Ontario Water Resources Commission are 15 ppm for both BOD and SS and these objectives are met, a large percentage of the time, at other OWRC plants. The Waterloo plant, however, due to the overloading and pH variations, was not able to even approach these objectives.

The percent reduction through the plant (Table 2) averaged 84 and 83 percent respectively for BOD and suspended solids.

(2) Aeration Section

The operating data for the aeration section of the plant is recorded in Table 3. The third column, pounds of BOD per 100 pounds of mixed liquor suspended solids, indicates the loading imposed upon this section. This process is primarily a biological one and requires loadings within certain ranges to operate most efficiently. Best operation is noted with loadings from 20 to 30 pounds of BOD per 100 pounds of MLSS per day.

From the table it is evident that the average daily loading per month exceeded this range most of the time and many of the months display loadings in excess of 50. A loading of 50 or more will result in a "bulking" sludge. This is a sludge which will not settle and has not been properly oxidized. Therefore, it is evident from this table that the loading on the aeration section is sufficiently large most of the time to cause bulking. The loadings on individual days would also be much higher than the average daily loading per month.

The last column in this table (cubic feet of air per gallon of sewage) reflects again the strength of the sewage. The average consumption of air per gallon of sewage at other OWRC plants during 1962 ranged approximately from 1.5 to 2.0 cubic feet per gallon. This is considerably less than the figure of 5.5 which was the average consumption at Waterloo during the year. Air is required for the removal of BOD and usually from 600 to 1000 cubic feet of air per pound of BOD removed is utilized. The yearly average of 996 at Waterloo is within this range.

Variations in pH were again quite noticeable during 1962. These variations have a most marked effect on the operation of the aeration portion of the plant. A biological population can be developed for most pH values but it is impossible for this population to survive in a media whose pH is varying rapidly over a large range. On July 6th, a maximum pH of 11.4 and a minimum of 3.6 was recorded. Other values of pH recorded during the year ranged from 11.8 to 2.0.

Therefore, even without the high BOD loadings on the aeration section, it is quite probable that difficulties would be experienced in the operation of this section. In fact, it is very possible that the present loading could be handled by the plant if there was little or no variation in the pH of the sewage.

(3) Vacuum Filtration

The vacuum filter results are recorded in Table 4 and shown in Graph # 8. As a result of the increased concentration of BOD and SS and a larger volume of sewage, the amount of sludge to be filtered during 1962 increased considerably over that experienced during 1961. Graph # 8 indicates that 2,035 tons of dry solids were filtered and that this represents a 75% increase over the amount filtered during the previous year. This increased volume of sludge added considerably to the cost of operation during the year.

Renovations made to the skip hoist during 1961 made it possible to filter at a greater rate during 1962. Although the amount of sludge increased by 75%, the filter hours went up only by 25%.

The 2,035 tons of dry solids filtered required 275 tons of lime (13.5%) and 82 tons of lime (4%) for coagulation. These dosages are slightly higher than those experienced with similar sludges in the United States. However, this increase in chemical demand can be attributed to the hardness of the water in the Waterloo area. The average rate of filtering (3.7 pounds per square foot per hour) was a decided improvement over the rate experienced in 1961 (2.6 pounds per square foot per hour) and resembles more closely the rates attained at similar plants.

SUMMARY

The quantity of material treated by the plant increased considerably during 1962 as compared with 1961. There was a 13% increase in flow, 50% increase in pounds of BOD and an 83% increase in the pounds of suspended solids. This extra loading resulted in a 75% increase in the amount of sludge to be filtered and increased the hours of operation of the filter at the plant.

The plant was again plagued with rapid and extreme pH variations as well as the shock loads indicated above. The result was poor settling in the primary clarifier, excessive usage of air and a poor quality of effluent.

RECOMMENDATIONS

A very comprehensive report was prepared in March of 1962 which covered the past operating experiences and recommended plant additions. This Annual Report indicates that the loadings reported in March have increased considerably and, therefore, again stresses the importance of carrying out the recommendations made in the March report.

PLANT PERSONNEL

The Waterloo WPCP is under 16 hour supervision 7 days per week. This supervision is provided by a Chief Operator and 6 Operators. The staff are as follows :-

E. Hay	-	Chief Operator
A. Franz	-	Operator
R. Gellatly	-	Operator
F. Hamer	-	Operator
R. Matthews	-	Operator
R. Selence	-	Operator
B. Snider	-	Operator

The design of this plant does not provide flexibility for operation and this coupled with a heavy load placed much responsibility on the operators. A break-down of almost any equipment in the plant would result in adverse operating conditions.

However, through the operators' efforts, there were relatively few break-downs and operation was consistent through the year.

The Intermediate Sewage Operators Course sponsored by the OWRC was attended by Mr. E. Hay in the spring and by Mr. B. Snider in the fall. Mr. E. Hay also attended the Water Pollution Control Federation Conference in Toronto during the fall.

Weekly courses, commencing on October 24th, were held at the plant for the men. Mr. E. Hay gave instructions concerning the various phases of sewage treatment to the men and reported much interest and co-operation from them. It was anticipated that if interest was maintained, the course would continue through the winter months.

OPERATING COSTS

A resumé of the expenses by month is given in Table 6.

The actual expenses for operation, which were incurred at the plant during the year, exceeded the estimate by $4,441.83. A portion of this excess resulted from the payment of taxes ($2,959.84) for the first time at the plant. Neglecting taxes, the budget estimate was exceeded by $1,481.99.

A further breakdown of the expenses is given below:

ITEM	1962 BUDGET	1962 ACTUAL	DIFFERENCE
Payroll	$ 33,400	$ 31,270.62	+ $ 2,129.38
Fuel	1,300	1,663.08	- 363.08
Power	18,000	18,078.92	- 78.17
Chemicals	15,800	19,837.92	- 4,037.92
Gen. Supplies	3,000	2,824.92	+ 175.08
Equipment	1,500	1,587.14	- 87.14
Rep. & Maint.	2,000	860.25	+ 1,139.75
Sundry	7,000	10,319.73	- 3,319.73
	$ 82,000	$ 86,441.83	- $ 4,441.83
	Less Taxes	2,959.84	
		$ 83,481.99	- $ 1,481.99

PAYROLL

Budget -$33,400 Actual - $31,270.62 Difference - $2,129.38

The actual expenditure was less due to the release of the casual labourer which resulted when a sludge haulage contract was obtained.

FUEL

Budget - $1,300 Actual - $ 1,663.08 Difference - $363.08

A full tank of fuel was purchased late in the year and, as a result, the actual fuel expenditure exceeded the estimate.

POWER

Budget - $18,000 Actual - $18,078.17 Difference $78.17

It was expected during the year that the power costs would exceed the estimate. The increased flow and strength of the sewage had necessitated longer filter runs and the change in process required more power. However, this trend was offset by the reductions in power costs resulting from the installation of a new transformer during the summer months.

CHEMICALS

Budget - $15,800 Actual - $19,837.92 Difference -$4,037.92

Past experience and more laboratory control has resulted in more efficient use of chemicals for filtering. However, the 75% increase in the amount of sludge to be filtered resulted in a 25% increase in the use of chemicals.

GENERAL SUPPLIES

Budget - $3,000 Actual - $2,824.92 Difference - $175.08

Supplies for the renovation of the air pipe lines ($175.77), the vacuum filter ($417.03), skiphoist ($111.75), chemical pumps $$291.58) and chemicals for the removal of scale from the filter ($565.65) were the main expenses incurred under this item.

EQUIPMENT

Budget - $1,500 Actual - $1,587.14 Difference - $87.14

A large power lawnmower with a sickle bar attachment was purchased during the year at a cost of $605.65. Other items purchased were a gas mask with separate air supply ($250), a submersible pump ($102.70), two sump pumps ($150.38), a pipe threader ($61.84) and small hand tools including an electric drill and wrenches, etc.

REPAIR AND MAINTENANCE

Budget - $2,000 Actual - $860.25 Difference $1,139.75

Repair and maintenance was kept to a minimum during the year in an attempt to keep expenses down. There is a great deal of maintenance required at the plant but it is anticipated that much of this can be done during and after construction of the extension.

SUNDRY

Budget - $7,000 Actual - $10,319.73 Difference - $3,319.73

The large deficit in this item resulted from the payment of $2,959.84 in taxes. Approximately $4,000 was spent on sludge removal during the latter half of the year. This expense was incurred as a result of the decision to remove sludge by contract. Previously a casual labourer had been employed to operate a truck owned by the plant.

UNIT OPERATING COSTS

The total operating cost for 1962 was $86,441.83. This represents a cost of 11.8¢ per million gallons which is higher than similar plants. The higher unit cost has resulted from the above average strength of sewage.

The unit cost per pound of BOD removed is 2.6¢ which is less than the average of 4 cents experienced at similar plants.

YEAR	MG TREATED	TOTAL COST	COST/1000 GAL	COST/CAPITA/YEAR
*1960	453	$ 34,233	7.5¢	$ 2.57
1961	650	80,710	12.4¢	3.90
1962	737	86,442	11.8¢	3.98

* Plant not in operation for the full year.

VACUUM FILTER COSTS

Labour: 3,683 hours for 1¼ men @ $1.87 =	$ 8,640
$FeCl_3$: 163,868 @ $6.55 per cwt. =	10,700
Lime: 550,876 @ $17.50/ton =	4,820
Power: Estimate at $200/month =	2,400
Repairs, maintenance and supplies for filter =	1,455
	$ 28,015

Tons of dry solids filtered = 2,040

Therefore, cost of filtering = $13.60 per dry ton of solids.

TABLE I

FLOW RECORDS MGD

MONTH	ABSOLUTE MAXIMUM	ABSOLUTE MINIMUM	MAXIMUM 24 HOUR FLOW	AVERAGE 24 HOUR FLOW	MINIMUM 24 HOUR FLOW	TOTAL MONTHLY FLOW M.G.	PLANT BYPASS HOURS	
							PLANT	PRIMARY TANK
Jan.	4.2	0.2	2.50	1.92	1.17	59.67	nil	144 *
Feb.	4.0	0.4	2.73	2.06	0.86	57.72	nil	460 *
March	4.2	0.6	3.13	2.48	1.55	76.69	nil	nil
April	4.0	0.5	2.72	2.28	1.37	68.19	nil	nil
May	4.4	0.6	2.52	2.04	1.15	63.26	nil	24 *
June	4.4	0.2	2.61	2.01	1.07	60.28	nil	nil
July	3.9	0.1	2.19	1.60	0.87	49.53	nil	nil
August	4.6	0.1	2.43	1.79	0.80	61.09	nil	96 *
Sept.	3.9	0.1	2.33	1.79	1.15	52.53	nil	nil
Oct.	4.4	0.1	2.93	1.88	1.06	58.70	nil	nil
Nov.	4.9	0.3	2.78	2.19	1.29	67.02	nil	nil
Dec.	4.7	0.2	2.67	2.01	1.32	62.34	nil	8
TOTAL						737.02		
AVG.	4.3	0.3	2.63	2.00	1.14	61.42		

NOTE: All flow rates are expressed in Millions of Gallons per Day
* 50 % of Flow Bypasses Primary Tank Directly to Aeration Section

TABLE 2

GRIT, BOD AND SS REMOVAL

MONTH	B O D				S S				GRIT REMOVAL CU. FT.
	Influent ppm	Effluent ppm	% Reduction	Tons Removed	Influent ppm	Effluent ppm	% Reduction	Tons Removed	
Jan.	479	110	77	110	422	159	62	78	35
Feb.	625	156	75	135	541	91	83	130	19
March	557	168	70	149	325	101	66	86	35
April	643	85	87	190	544	115	79	146	49
May	703	118	83	185	472	112	76	114	60
June	597	99	83	150	414	81	81	100	68
July	623	71	89	136	381	47	88	83	46
Aug.	1039	111	89	283	693	73	90	189	57
Sept.	895	114	87	205	810	51	94	198	45
Oct.	916	73	92	247	623	38	94	172	50
Nov.	830	132	84	234	465	71	85	132	49
Dec.	1280	70	95	377	781	48	94	228	49
TOTAL	9187	1307	1011	2401	6471	987	992	1656	562
AVG.	766	109	84	200	539	82	83	138	47

NOTE:
- Lab analysis results for December were taken from one composite sample
- Approximately 100 eight hour composite samples were obtained during the year.
- PPM - parts per million

Grit - 0.76 cubic feet per million gallons
BOD - 3.82 tons per million gallons
SS - 2.96 tons per million gallons

TABLE 3

AERATION SECTION

MONTH	PRIM. EFF. BOD PPM	ML. SS PPM	LBS. BOD PER 100 LBS MLSS	TONS BOD REMOVED	CU.FT. AIR PER LB BOD REMOVED	CU.FT. AIR PER GAL. OF SEWAGE
January	1317	3186	53	359	485	5.8
February	1212	3041	51	308	512	5.4
March	899	2503	59	288	506	4.1
April	549	2911	30	158	930	4.3
May	713	1988	45	188	1059	5.5
June	433	2458	23	103	1753	5.6
July	500	2617	19	106	1765	7.0
August	607	2180	35	152	1296	5.7
September	825	2075	43	187	1010	6.4
October	664	2002	76	173	966	5.9
November	700	1756	64	190	839	4.8
December	740	2405	41	209	834	5.6
TOTAL:	9159	29122	539	2421	11955	66.1
AVG.	763	2427	45	202	996	5.5

NOTE: Prim. Eff. - Primary Effluent
MLSS - Mixed Liquor Suspended Solids
Design Loadings - FSIWA Manual of Practice No. 8
LB BOD/100 LBS MLSS - 20 to 30
cu.ft. Air /LB BOD Removed - 600 to 1000
cu.ft. Air / Gal - 0.2 to 1.5 *
* Sewerage and Sewage Treatment Eighth Edition

TABLE 4

VACUUM FILTER RESULTS

MONTH	TOTAL HOURS OF OPERATION	SLUDGE			CHEMICALS				AVERAGE YIELD LBS./SQ.FT./HR.
		Total Gals. to Filter	Total Lbs. Dry Solids Filtered	% Solids Raw Sludge	Pounds Used		Percent Used		
					Lime	FE Cl_3	Lime	FE Cl_3	
January	281.5	601,644	265,391	4.6	31,236	11,450	11.0	4.0	3.2
February	297.5	651,738	303,057	4.7	35,424	15,733	11.7	5.2	3.4
March	341.0	681,440	282,982	4.0	38,040	15,985	13.2	5.8	2.7
April	360.5	753,474	374,852	5.0	36,204	14,363	9.7	3.4	3.4
May	334.0	794,855	408,402	5.1	44,482	19,604	10.6	4.8	4.0
June	346.0	868,281	413,100	4.8	62,550	19,220	10.0	4.3	3.9
July	200.0	688,726	311,622	4.5	55,190	14,624	12.6	4.8	5.2
August	295.0	727,869	317,013	4.3	56,650	11,497	12.0	3.7	3.6
September	348.0	826,562	343,246	4.0	62,800	12,921	13.1	3.8	3.3
October	311.5	794,739	388,924	4.9	46,350	10,389	8.4	2.8	4.2
November	298.5	748,491	265,178	4.7	41,850	9,451	8.9	2.9	3.0
December	274.5	698,750	405,599	4.9	40,100	8,631	8.4	2.6	4.9
TOTAL	3,688.0	8,836,569	4,079,366	55.5	550,876	163,868			44.8
AVERAGE	307.3	736,381	339,947	4.6	45,906	13,656	13.5	4.0	3.7

NOTE: Vacuum filter area equals 300 square feet.

TABLE 5

MONTH	SLUDGE REMOVAL		FUEL OIL (Gals)
	Cu. Yards	Cu. Yds. Per M.G. Flow	
January	1,473	24.7	2,000
February	1,679	29.1	1,750
March	1,734	22.6	1,665
April	1,301	19.1	1,000
May	1,976	31.2	125
June	1,469	24.4	NIL
July	1,361	27.5	NIL
August	1,202	19.7	NIL
September	1,244	23.7	NIL
October	1,252	21.4	960
November	1,216	18.1	1,455
December	1,073	17.2	2,043
Total	16,980	278.7	10,998
Average	1,415	23.2	917

TABLE 6

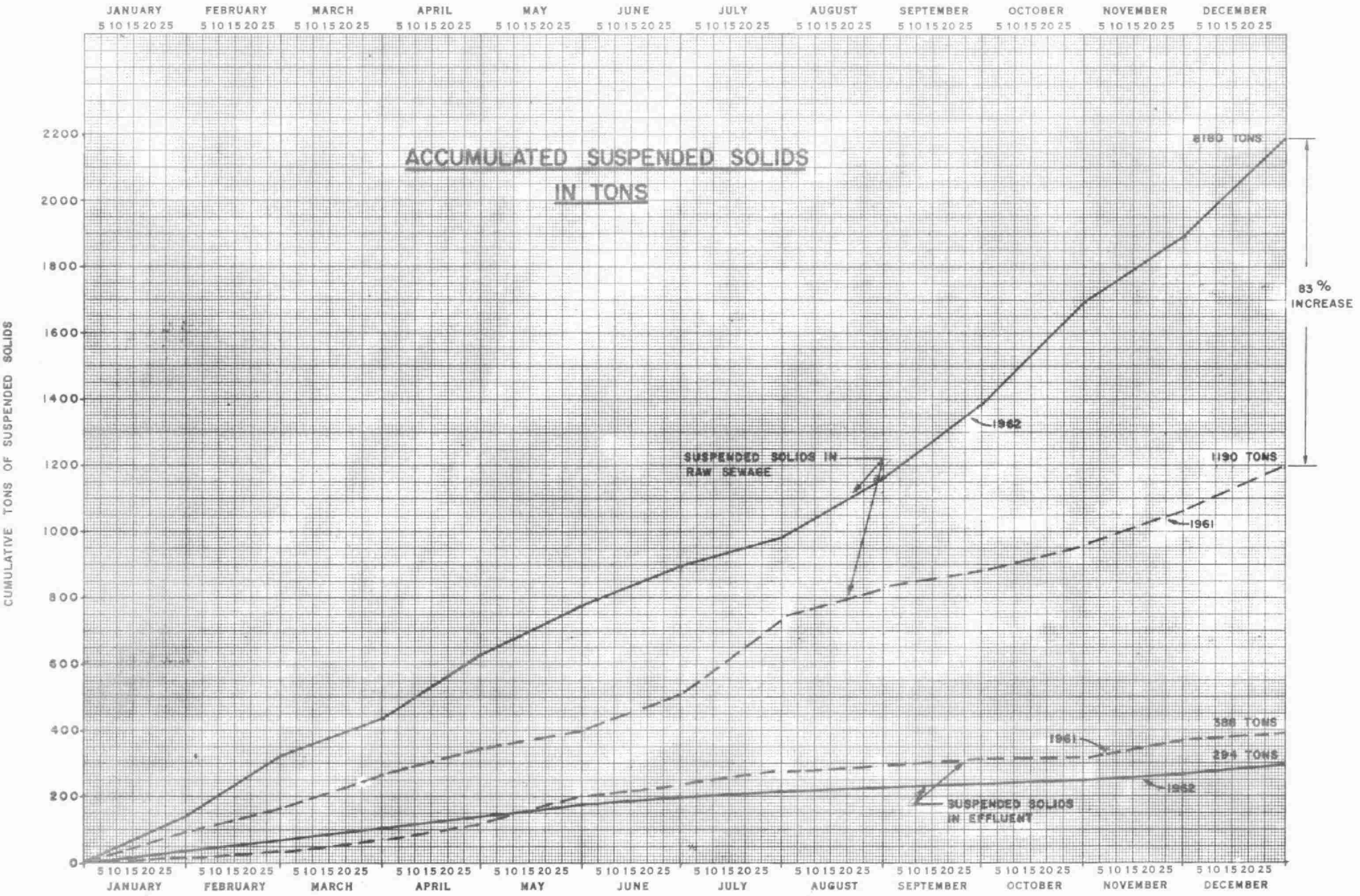
OPERATING BUDGET AND EXPENSES BY THE MONTH - 1962

MONTH	EXPENDITURE	PAYROLL	CASUAL PAYROLL	FUEL	POWER	CHEMICAL	GENERAL SUPPLIES	EQUIPMENT	REPAIR AND MAINTENANCE	WATER	SUNDRY	ACTUAL	FORECAST
JANUARY	3643.79	2135.04	252.76	223.95	1724.69	459.27	35.75	521.39			15.63	3,644	6,833
FEBRUARY	5442.98	2252.68	208.62	288.96	1790.46	121.59	183.27	442.06	56.19		99.15	9,087	13,666
MARCH	12146.20	2840.88	247.09	231.65	1766.35	3599.86	697.21		150.56		3312.60	21,233	20,500
APRIL	3589.07	2665.90	244.50	217.13	1637.58	(1568.86)*	163.38	61.84	45.00		122.60	24,822	27,333
MAY	13188.64	2156.53	105.46	89.21	1570.64	3012.35	596.30	186.96	83.47		5387.72	38,011	34,166
JUNE	7085.08	2251.28	50.22		1622.09	2705.19	333.24	6.55	10.28		106.23	45,096	41,000
JULY	7495.48	2247.53	209.96	42.13	1639.03	1504.85	202.89	85.00			1564.09	52,591	47,833
AUGUST	8639.75	3376.54	443.04		1590.22	2740.75	118.62		117.38		253.20	61,231	54,666
SEPTEMBER	3439.91	2254.90	204.57	39.97	1633.05	2313.27	176.80	150.38	188.72		3521.75	64,671	61,500
OCTOBER	7396.74	2254.90		245.94	1683.48	1843.73	46.83				1321.86	72,068	68,333
NOVEMBER	6746.70	2261.80		284.14	1557.78	1656.28	169.98		(31.00)*		847.72	78,814	75,167
DECEMBER	7627.49	3306.42			1587.49	1449.64	100.65	132.96	239.65		810.67	86,442	82,000
TOTAL	86441.83	29304.40	1966.22	1663.08	18078.17	19837.92	2824.92	1587.14	860.25		10319.73		
AVERAGE	7200.00	2440.00	164.00	138.00	1505.00	1655.00	236.00	132.00	72.00		850.00		

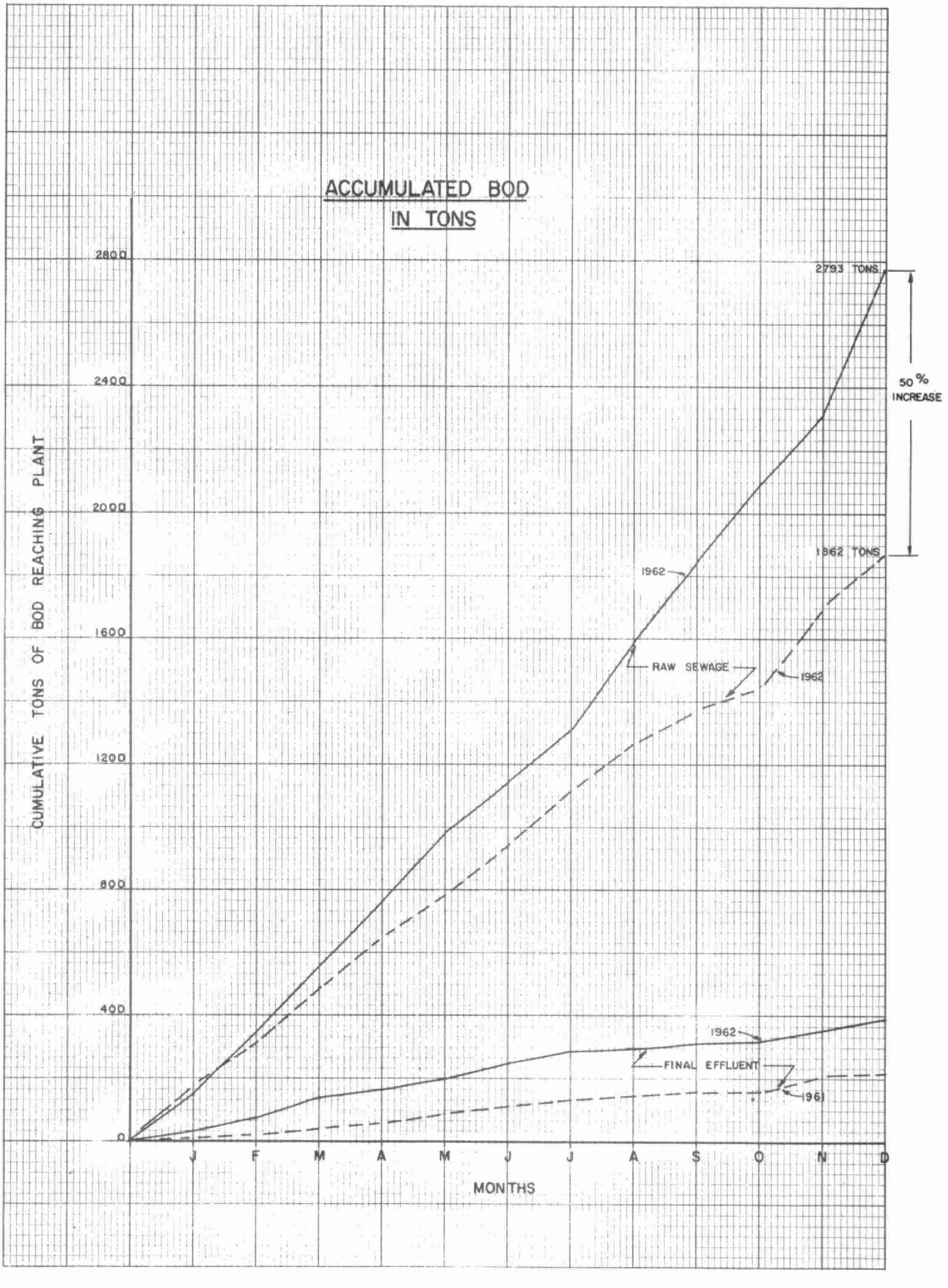
* CREDIT

K+E 1 YEAR BY DAYS X 250 DIVNS.
KEUFFEL & ESSER CO.
CALENDAR YEAR
358-142
MADE IN U.S.A.

GRAPH I

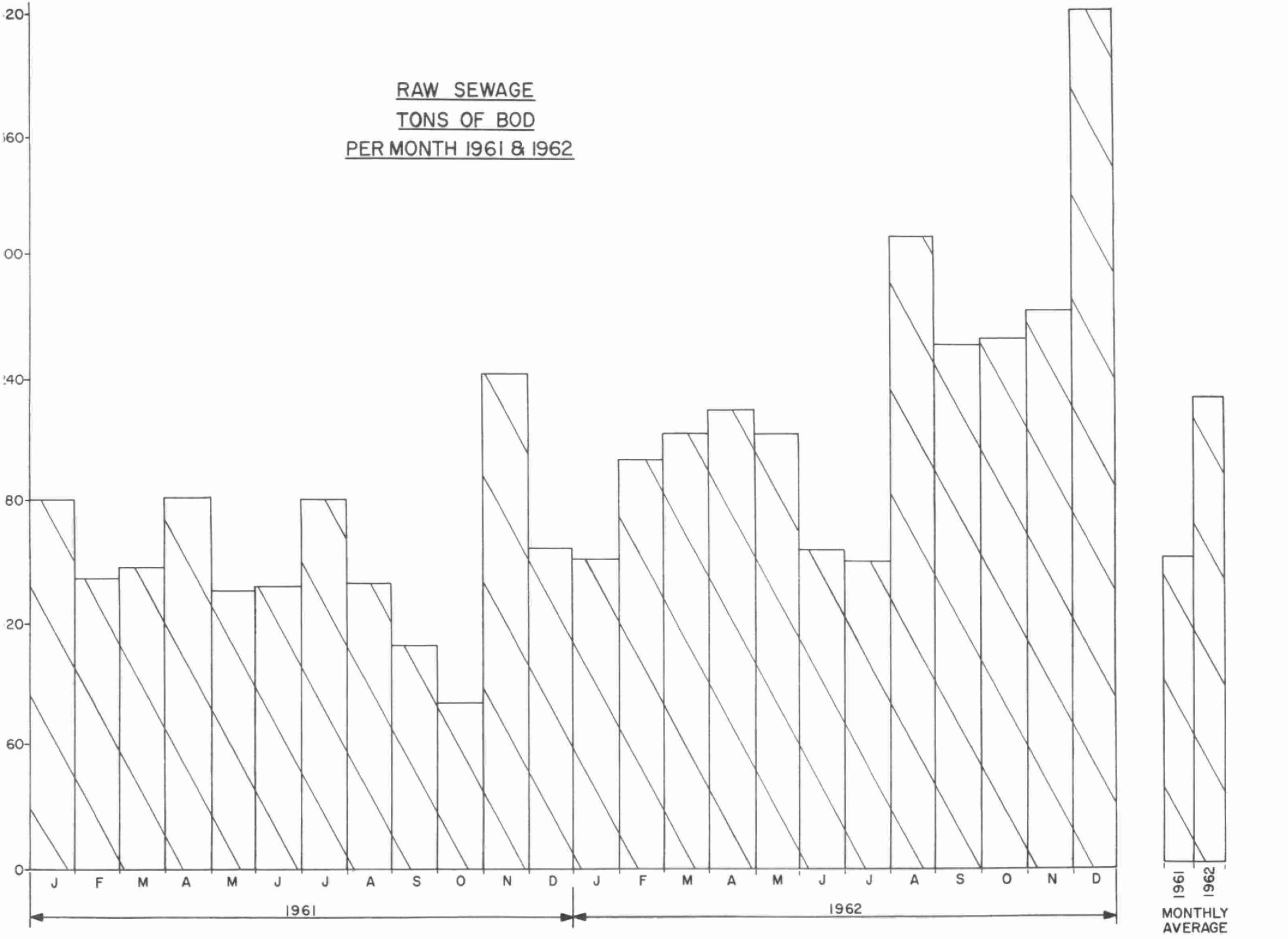


GRAPH 2

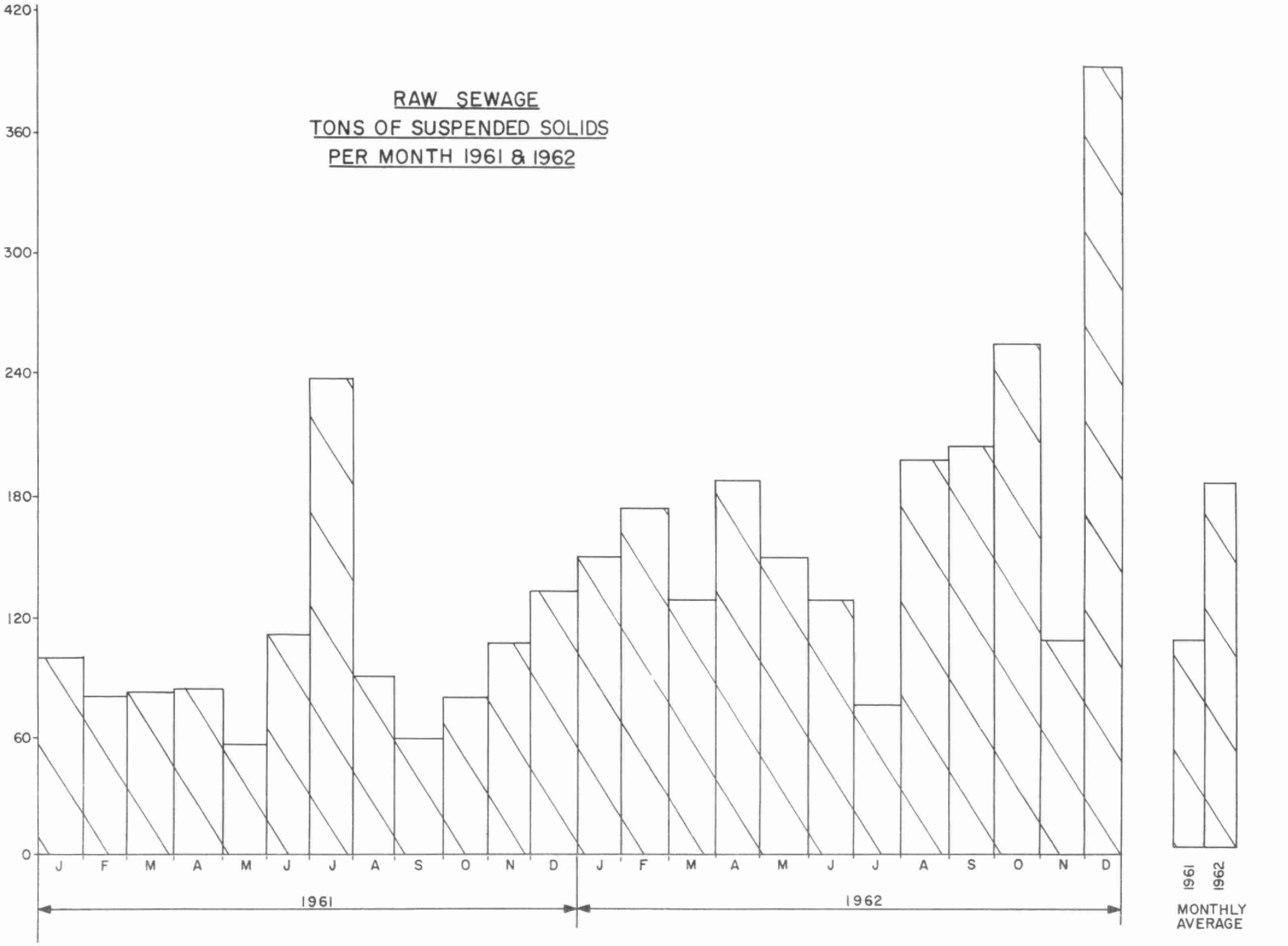


G 8 - 21
12 X 20 to the inch
MADE IN CANADA
MICROGRAPH

GRAPH 3

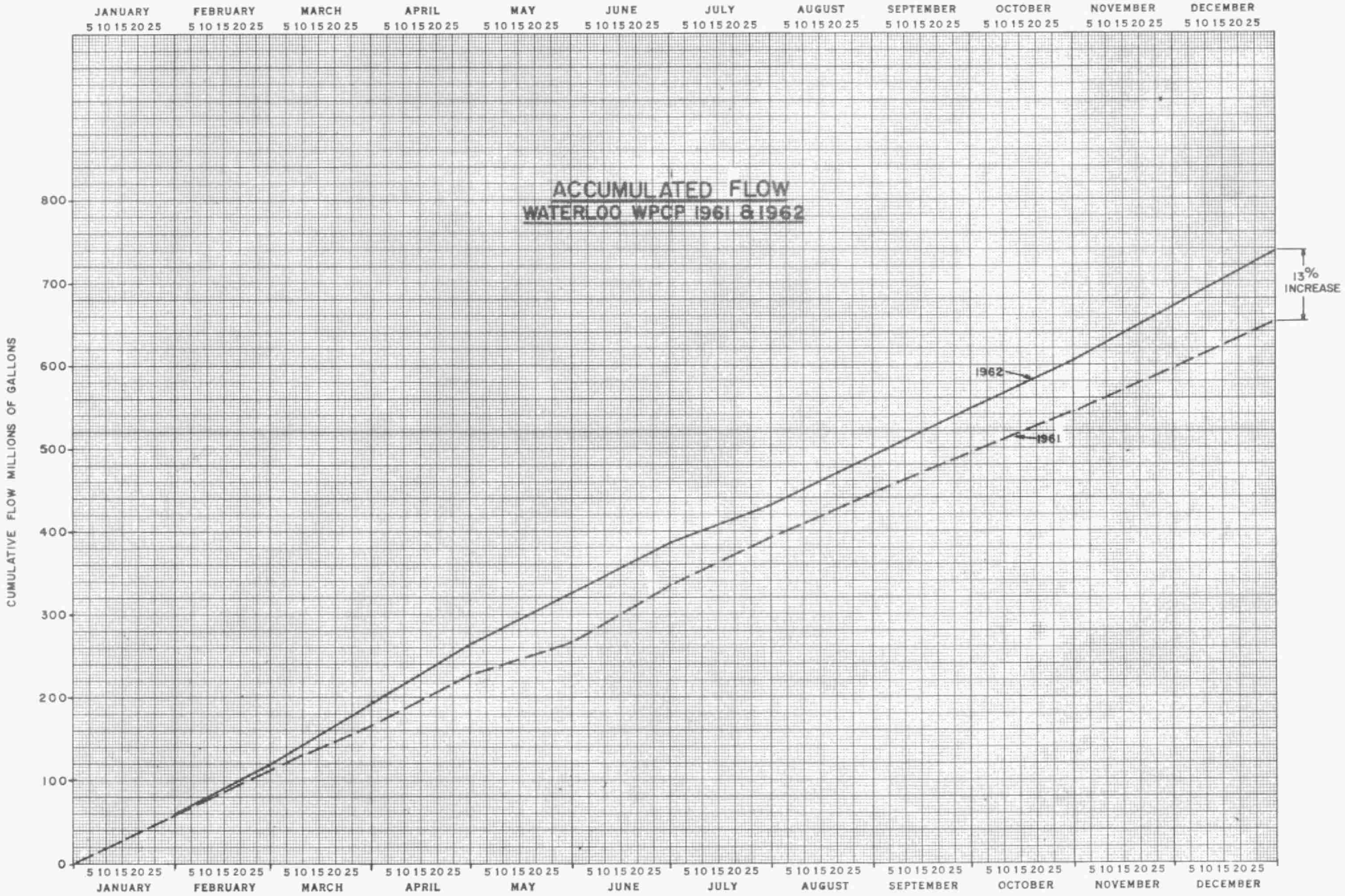


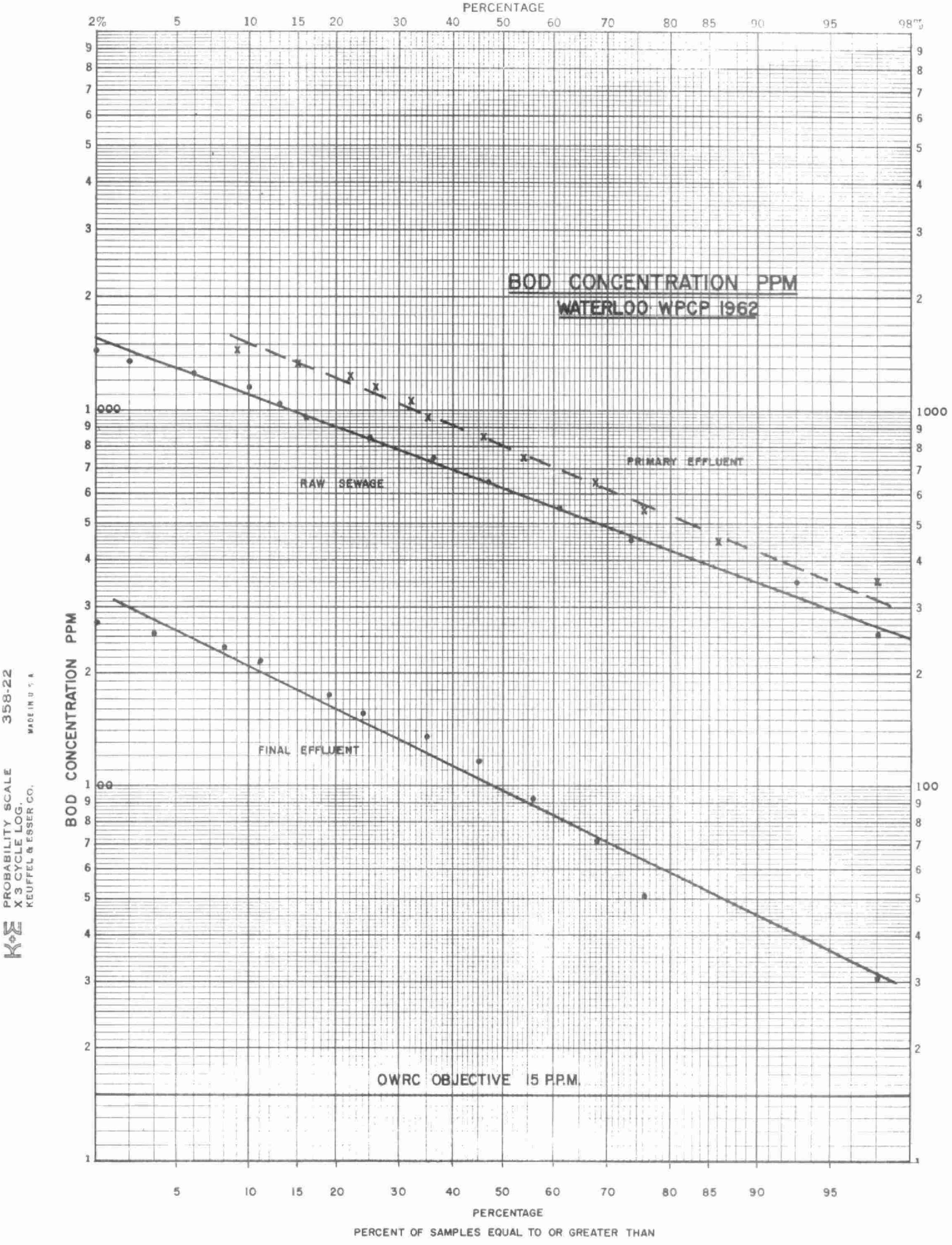
RAW SEWAGE
TONS OF BOD
PER MONTH 1961 & 1962


RAW SEWAGE
TONS OF SUSPENDED SOLIDS
PER MONTH 1961 & 1962
420
360
300
240
180
120
60
0
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
S
O
N
D
1961
1962
1961
1962
MONTHLY AVERAGE

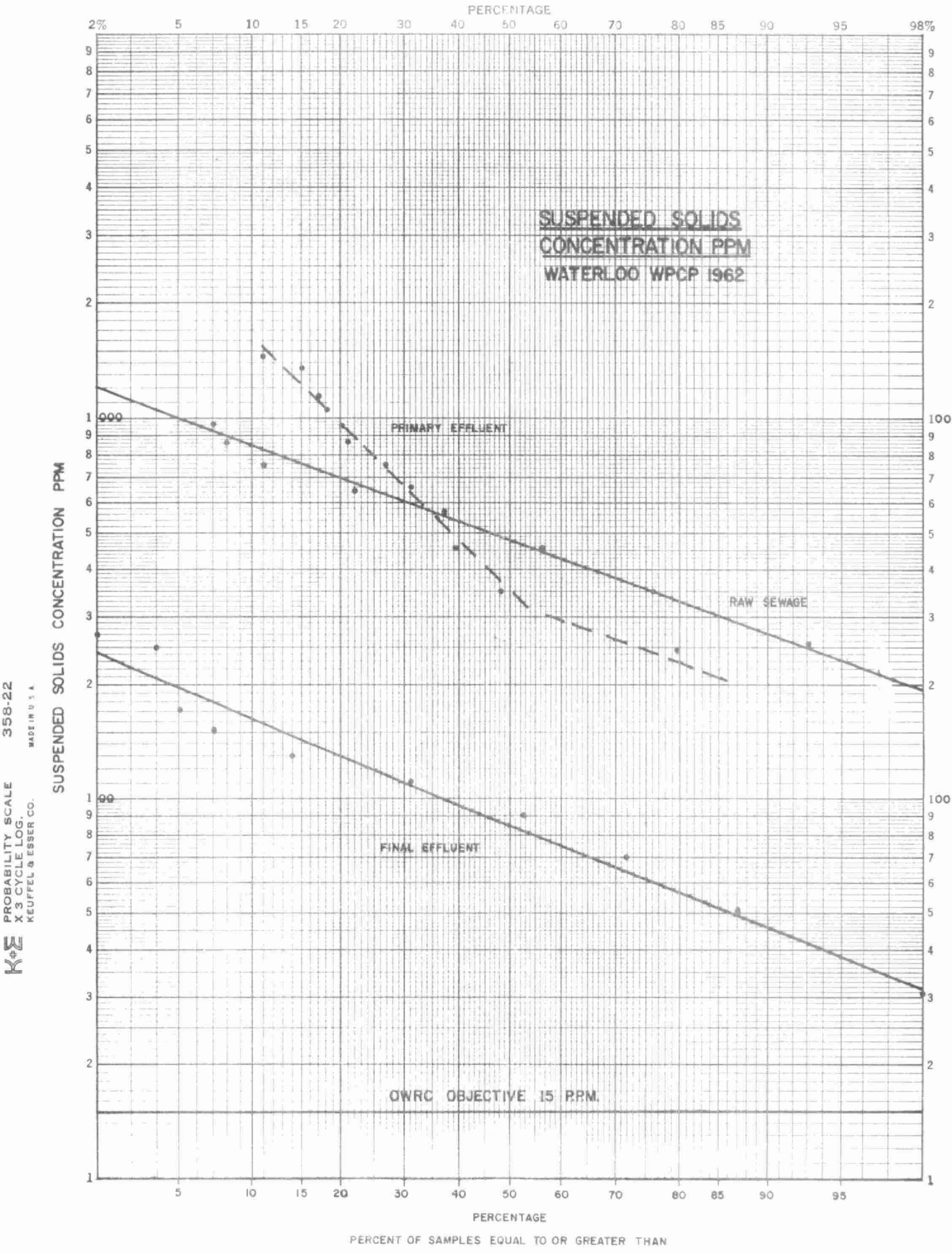
K+E 1 YEAR BY DAYS X 250 DIVNS. 358-142
KEUFFEL & ESSER CO. MADE IN U.S.A.
CALENDAR YEAR

GRAPH 5

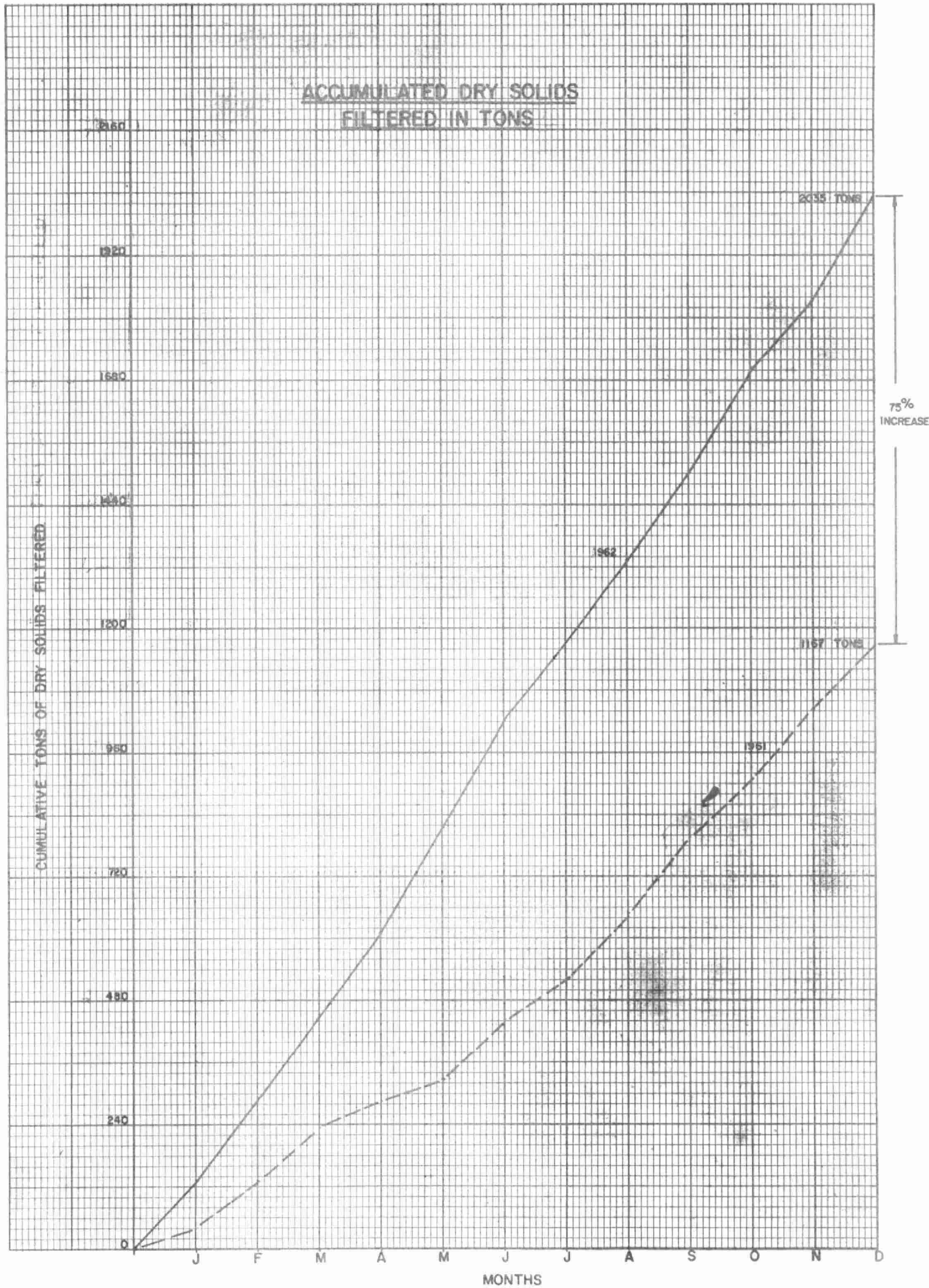



PERCENTAGE
2%
5
10
15
20
30
40
50
60
70
80
85
90
95
98%
BOD CONCENTRATION PPM
WATERLOO WPCP 1962
1 000
1000
1 00
100
9
8
7
6
5
4
3
2
1
RAW SEWAGE
PRIMARY EFFLUENT
FINAL EFFLUENT
OWRC OBJECTIVE 15 P.P.M.
BOD CONCENTRATION PPM
PERCENTAGE
PERCENT OF SAMPLES EQUAL TO OR GREATER THAN
K+E PROBABILITY SCALE X 3 CYCLE LOG. 358-22
KEUFFEL & ESSER CO. MADE IN U.S.A.

GRAPH 7


SUSPENDED SOLIDS
CONCENTRATION PPM
WATERLOO WPCP 1962
PERCENTAGE
2%
5
10
15
20
30
40
50
60
70
80
85
90
95
98%
1000
100
1
9
8
7
6
5
4
3
2
SUSPENDED SOLIDS CONCENTRATION PPM
PRIMARY EFFLUENT
RAW SEWAGE
FINAL EFFLUENT
OWRC OBJECTIVE 15 P.P.M.
PERCENTAGE
PERCENT OF SAMPLES EQUAL TO OR GREATER THAN
K&E PROBABILITY SCALE X 3 CYCLE LOG.
KEUFFEL & ESSER CO.
358-22
MADE IN U.S.A.

GRAPH 8



G 8-21
12 X 20 to the inch
MADE IN CANADA
MICROGRAPH

LABORATORY LIBRARY

96936000119598